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DERWENT-WEEK: 199627
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TITLE: Leak detector testing vacuum systems air-tightness
- has body, heater
with dc source and thermal sensor in form of pyroelectric
converter connected
to it and meter made as dc amplifier and differential
amplifier

INVENTOR: GORELIK, L L; MOROZOV, A G

PATENT-ASSIGNEE: GORELIK L L[GOREI]

PRIORITY-DATA: 1985SU-3973605 (October 31, 1985)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
PAGES	MAIN-IPC	
SU 1342200 A1	October 20, 1995	N/A
003	G01M 003/16	

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO
APPL-DATE		
SU 1342200A1	N/A	1985SU-3973605
October 31, 1985		

INT-CL (IPC): G01M003/16

ABSTRACTED-PUB-NO: SU 1342200A

BASIC-ABSTRACT: The heater (2) is mounted in the body (1).
The pyroelectric
converter (3) in the shape of a plate is mounted on the
heat sink (4) through
the thermal insulation layer. The meter is in the form of
a dc amplifier (6)
and a differential amplifier (9) connected to the amplifier
(6) output through
the RC-circuits (7,8). The amplifier (9) has different
input time constants.
The gas sample enters the body (1) and changes the gas
thermal conductivity and
the heat flux temperature. The converter (3) ferroelectric

polarization moment
changes and the current pulse arrives at the amplifiers
(6,9). The RC-circuits
eliminate the passage of the parasitic signals with a time
constant greater
than the amplifier (9) time constant. The leak detector
threshold sensitivity
is determined by the pyroelectric converter noise and heat
flux fluctuations
caused by pressure and gas separation changes in the tested
vacuum system.

USE/ADVANTAGE - Leak detector is used for testing
air-tightness of vacuum
systems. Its sensitivity and reliability are

increased. Bul. 29/20.10.95

CHOSEN-DRAWING: Dwg.1/2

TITLE-TERMS:

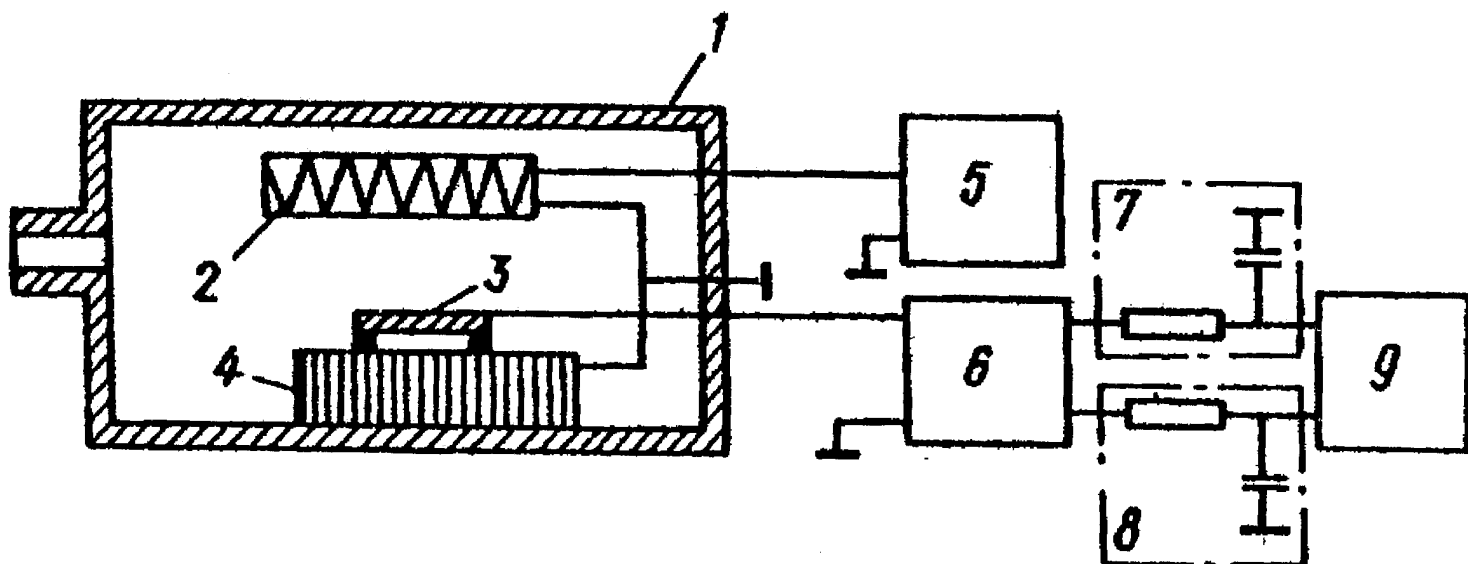
LEAK DETECT TEST VACUUM SYSTEM AIR TIGHT BODY HEATER DC
SOURCE THERMAL SENSE
FORM PYROELECTRIC CONVERTER CONNECT METER MADE DC AMPLIFY
DIFFERENTIAL AMPLIFY

DERWENT-CLASS: S02

EPI-CODES: S02-J06A1;

SECONDARY-ACC-NO:

Non-CPI Secondary Accession Numbers: N1996-224290



TDB-ACC-NO: NN820669

DISCLOSURE TITLE: Pyroelectric Technique for Measurement of Thermal Conductivity. June 1982.

PUBLICATION-DATA: IBM Technical Disclosure Bulletin, June 1982, US

VOLUME NUMBER: 25

ISSUE NUMBER: 1

PAGE NUMBER: 69 - 74

PUBLICATION-DATE: June 1, 1982 (19820601)

CROSS REFERENCE: 0018-8689-25-1-69

DISCLOSURE TEXT:

6p. Use is made of pyroelectric sensors to measure thermal

conductivity while avoiding the need for small temperature sensors

which are easily adapted to measurement of thin films and layers.

Other techniques do not appear to exist at room temperature.

- The progress of modern integrated circuit technology is limited

more by the removal of heat from chips and packages than by the

ability to construct densely packed circuits. In optimizing heat

removal, knowledge concerning the thermal properties of thin films

and layered structures is exceedingly important. Similarly in the

aerospace industry the thermal properties of paints, coatings and

layers are important. In developing new sources of energy (e.g.,

solar cells) as well as in more efficiently utilizing existing

sources, the thermal properties of thin sheets, layers,

coatings or

layered structures play an important role.

- Numerous techniques exist for measuring the thermal conductivity and diffusivity of bulk materials. These include steady-state, transient and thermal wave techniques. A thorough review of techniques for measurement of thermal conductivity and diffusivity as well as experimental data may be found in (*).

- In this article we describe how pyroelectric sensors can be used to measure the thermal properties, particularly the thermal diffusivity, of thin films, layers, etc. In Fig. 1A, we show an embodiment of our technique. Here, a thin layer of material 2 is in intimate thermal contact with a pyroelectric crystal or ceramic substrate 3 which has very thin conducting electrodes 4 on either side. The material 2 is heated by a short burst of energy 1, which is illustrated in Fig. 1B. As the heat absorbed in material 2 diffuses into the pyroelectric substrate 3, a charge is produced on the electrodes 4 which then flows through the load resistor (R(L)) 5 to create a voltage V at terminal 6 which is monitored on a suitable device, such as a digital oscilloscope or other transient recording media.

Fig. 2 shows a typical curve of voltage versus time recorded in this way by the pulse in Fig. 1B, both starting at time zero. Analysis of the shape of this curve yields a value for the thermal diffusivity, α , of the sample where $\alpha = k/pC$, where k is the thermal conductivity, p the density, and C the heat capacity of the sample. The amplitude of the curve or the area under

the curve gives

a value for the heat capacity.

- Although over-simplified when applied to the present case, the

nature of the curve in Fig. 2 is understood from the solution to the

thermal diffusion equation in one dimension (see original).

- As a function of time this equation is qualitatively of the

same form as Fig. 2. The maximum temperature for fixed x occurs at

$t(\max) = (x/2)^2 / 2\alpha$. Interpreting x to be the thickness of

the sample and α its thermal diffusivity, one sees that the

curve scales as $x^2/2\alpha$.

- Numerous experiments have been formed on thin thermally

insulating films and layers at room temperature. These indicate that

this scaling law is approximately obeyed and that, using the measured

value of $t(\max)$ quite reasonable values of α are obtained.

Although the general nature of the curve in Fig. 2 is described by

the above equation, and the $x/2$ dependence has been confirmed and

the values of α thereby found are reasonable, this is not meant

as a quantitative analysis of the problem.

- A correct and detailed analysis of the voltage generated by the

circuit of Fig. 1 in the presence of a sinusoidal energy input with

absorption coefficient B , i.e., $I = I(0)e^{-Bx}/1/\omega$ yields the

following expression for the voltage $V(\omega)$ at the frequency ω

(see original).

Here: (see original).

- The above equation of $V(\omega)$ accurately describes the device

in the absence of thermal contact to the outside world. Heat loss to

the surrounding media could be readily included in the equations if

deemed necessary.

- In order to describe a transient experiment with frequency

components of the input heat described by $I(0)$ (see original) $I(0)$

(ω) y, correctly, the time dependent voltage is given by the

inverse LaPlace transform of $V(\omega)$, i.e., (see original). where

the above expression for $V(\omega)$ is used with $i(0)(\omega)$.

Generally, the burst of heat will be chosen so that $I(0)(\omega)$ is

independent of ω on the scale of interest (i.e., a delta function

heat source). This expression for $V(t)$ is in general non-trivial and

will probably require a computer to do a quantitative fit to the data

and thus obtain $\alpha(S)$ and $C(S)$.

- Since experiment shows that the transient response scales as

$x/2 / 4 \alpha t$, it is clear that in order for $I(t)$ to look like

a delta function (i.e., $I(\omega)$ independent of ω), the heat

pulse width Δt must obey ΔT much less than $x/2 / 4 \alpha$.

- For a typical polymer at room temperature (see original).

Thus, on taking $x=0.1$ cm we get Δt much less than 2.5 s. For

copper at low temperature α approximately $10 \text{ cm}^2/\text{S}$. On taking

$x=0.1$ cm we need Δt much less than 25 ns. For copper at room

temperature α approximately 1, thus for $x=0.1$ cm Δt much

less than 2.5 ms.

- The important features described here are now reviewed.

Pyroelectricity is used to measure thermal properties with a rapid,

simple apparatus for detection of thermal properties of thin films,

layers, and structures. It is adaptable to a wide variety of

materials over a wide temperature range. The heat

source can be

laser, E-beam, flashlamp, ion beam, IR resistive heating of sample, or any other means of applying a short burst of heat to the sample.

Unlike other thermal conductivity measuring schemes this one does not

require thermally small sensors. In fact, the pyroelectric sensor

can be quite massive compared to the sample.

A variety of pyroelectric materials are available including but not limited to PZT

(lead-zirconium-titanate) ceramics, LiTaO_3 , TGS, and Rochelle salt.

The present technique is particularly suited to thin layers and

films, and it is fast and exceedingly easy, requiring no significant

sample preparation. The technique is easily adaptable to liquids or

viscoelastic materials, such as rubbers.

- Thermal properties of composites of various types can be

studied by this technique. In some cases the sample may not absorb

the available incident radiation (heat). In this case a thermally

thin absorbing layer 7 can be applied to the outer surface of the

sample (Fig. 3). In many cases the analysis of this case is even

simpler than that when the sample absorbs the radiation (heat)

itself. Here, layer 7 is the thermally thin absorbing layer. This

technique is suited for the investigation of time dependent materials

changes, such as chemical reactions or polymerization, as long as the

time scale of reaction $t(R)$ is much greater than $x/2/\alpha$ that

the thermal transient is over before the material has changed.

- The technique is also a method of non-destructively measuring

the thickness of a material of known thermal diffusivity. In this

technique the pyroelectric sensor is not simply a temperature sensor.

In spite of the similarity of the data (Fig. 1) to the solution to

the thermal diffusion equation as described above, the voltage

detected is not simply related to the temperature, i.e., the

pyroelectric sensor is not a linear thermometer. In some cases it

may be desirable to measure the frequency dependent voltage $V(\omega)$

as the modulation frequency ω is varied. The comparison then

leads to values for the thermal properties of the sample. It should

be clear that samples which are both highly absorbing and do not

absorb heat may be studied with this technique.

- By choosing the types of heat input carefully it is possible to

study very thick samples. For example, a 10.6 μm laser pulse may be

used to study silicon circuits because light is transmitted through

the substrate and absorbed in the regions of metallization and

circuit detail, causing heating only there. Thus putting this

surface against a PZT crystal 3 will give a measure of the film(s)

thermal behavior even though the sample is thick. This situation is

sketched in Fig. 4, which shows a thick sample with a substrate 2

transparent to incident light.

- It should be clear that this technique provides a simple and

reliable technique for measuring the thermal contact between two

materials of known thermal properties. Therefore, the thermal

contact between a thermal piston and a silicon chip could be

determined in this way.

- This technique is particularly suitable for composite materials

(e.g., epoxy, fiberglass) for which the thermal

properties can be
anisotropic.

Reference

(*) Y. S. Touloukian, C. Y. Ho and M. C.
Nicolaou, "

Thermal Diffusivity, Thermophysical Properties of
1973.

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FIG. 1A

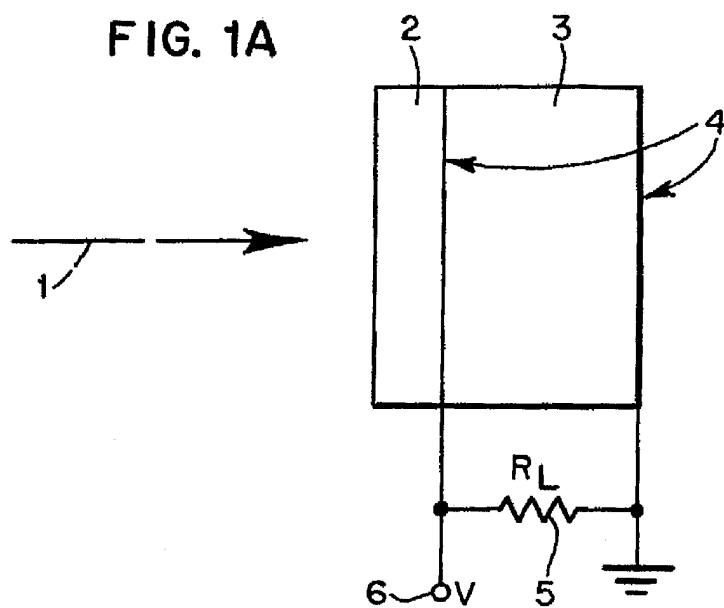


FIG. 1B

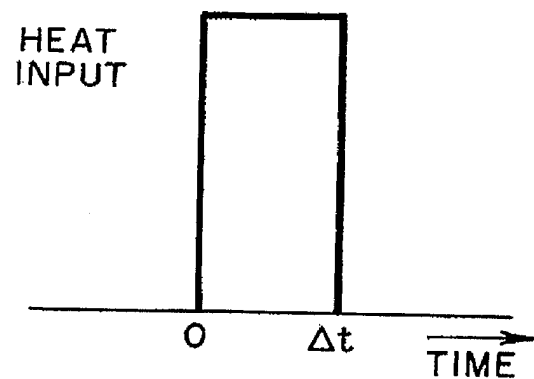
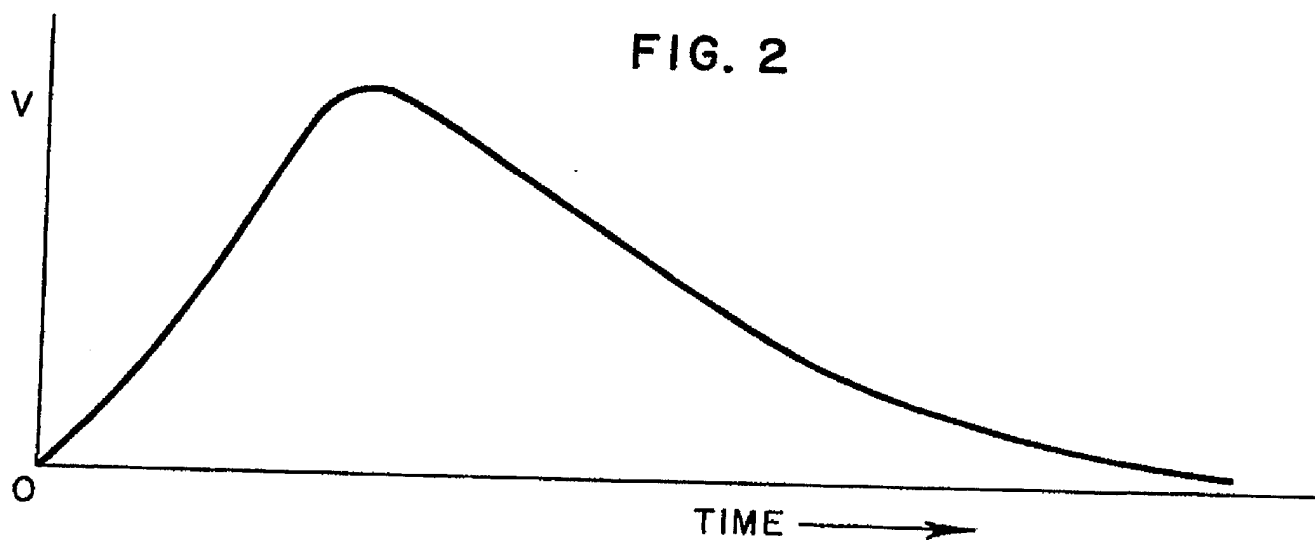


FIG. 2



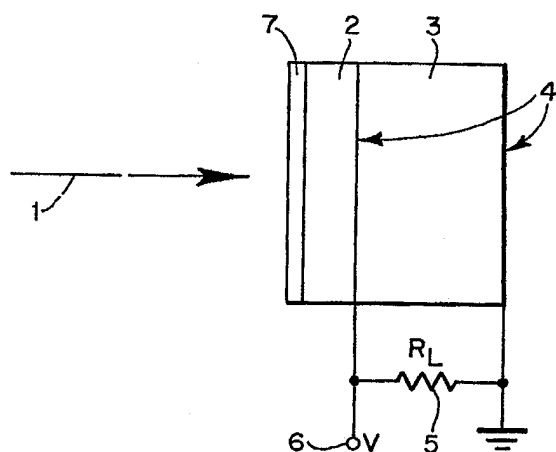


FIG. 3

$$T(x,t) = \frac{A}{t^{1/2}} e^{-\frac{x^2}{4\alpha t}} \quad A = \text{const.}$$

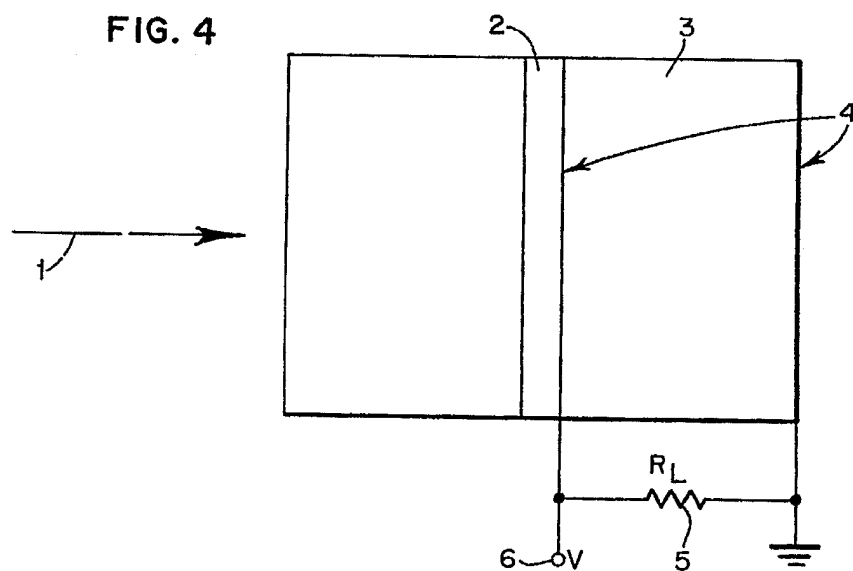


FIG. 4

$$V(\omega) = - \left(\frac{1}{1+i\omega\tau_0} \right) i\omega A R_L P \left(\frac{\tanh G l}{G l} \right) r_{G_S} \frac{B}{B^2 - G_S^2} \left(\frac{1}{2} \right) \frac{1}{\cosh G_S d} \cdot$$

$$\frac{[1 - e^{-Bd} (\cosh G_S d + \frac{G_S}{B} \sinh G_S d)]}{[r \tanh G_S d + \tanh G l]}$$

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments
1	BRS	L1	77	pyroelectric same power adj1 supply	USPA T	2003/03/1 1 14:32	
2	BRS	L2	10	pyroelectric same integrated adj1 circuit same heat\$3	USPA T	2003/03/1 1 14:22	
3	BRS	L3	9	pyroelectric same integrated adj1 circuit same heat\$3	US-P GPUB ; EPO; JPO; DERW ENT; IBM TDB	2003/03/1 1 14:22	
4	BRS	L4	79	pyroelectric same power adj1 supply	US-P GPUB ; EPO; JPO; DERW ENT; IBM TDB	2003/03/1 1 14:42	
5	BRS	L5	2	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 power adj1 (source or supply)	US-P GPUB ; EPO; JPO; DERW ENT; IBM TDB	2003/03/1 1 14:45	
6	BRS	L6	1	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 power adj1 (source or supply)	USPA T	2003/03/1 1 14:51	
7	BRS	L7	1	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 electric\$3 adj2 (energy or source or power)	USPA T	2003/03/1 1 14:50	

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments
8	BRS	L8	0	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 electric\$3 adj2 (energy or source or power)	US-P GPUB ; EPO; JPO; DERW ENT; IBM TDB	2003/03/1 1 14:50	
9	BRS	L9	0	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 electric\$3 adj2 (energy or source or power)	USOC R	2003/03/1 1 14:51	
10	BRS	L10	0	(lithium adj1 tantalate or litao3 or lithium adj1 niobate or linbo3 or li2so2h2o or pyroelectric) adj2 power adj1 (source or supply)	USOC R	2003/03/1 1 14:51	
11	BRS	L11	0	pyroelectric adj1 capacitor.ti.	USPA T	2003/03/1 1 14:52	
12	BRS	L12	19	pyroelectric adj1 capacitor	USPA T	2003/03/1 1 14:52	
13	BRS	L13	12	pyroelectric and capacitor.ti.	USPA T	2003/03/1 1 14:53	
14	BRS	L14	0	pyroelectric same capacitor.ti.	USPA T	2003/03/1 1 15:02	
15	BRS	L15	10	pyroelectric adj1 conver\$4	USPA T	2003/03/1 1 15:06	
16	BRS	L16	9	pyroelectric adj1 conver\$4	US-P GPUB ; EPO; JPO; DERW ENT; IBM TDB	2003/03/1 1 15:07	